

CAT. NO.
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CHEMISTRY MATH



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TRS-80

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PRODUCTS

**PC-2
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Chemistry Math™

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INTRODUCTION

The CHEMISTRY MATH™ package is a valuable tool for students who are familiar with the fundamentals of chemistry. Beginners can use the programs to practice the application of essential concepts and principles of chemistry. More advanced students will enjoy the convenience of this package that solves chemistry problems as rapidly as a calculator solves math problems.

The first eight programs perform basic chemistry calculations. The last two programs are handy references; one converts English units of measure to metric units, one is a periodic table of the elements.

CHEMISTRY MATH consists of:

- WTWTVOL** — Solves weight-weight and weight-volume problems.
- EQUILIB** — Calculates acid equilibria.
- IDEALGAS** — Performs ideal gas calculations.
- MOLNORM** — Calculates molarity/normality of solutions.
- BPFP** — Calculates boiling and freezing points of solutions.
- KSP** — Calculates solubility products.
- FORMWTS** — Calculates molecular weights.
- PH** — Calculates pH, OH^- , and H^+ concentrations of solutions.
- METRIC** — Converts English units of measure to metric units.
- ATOMWTS** — Finds atomic weights.

The PC-2 displays the results of its calculations to its full available accuracy — up to 10 digits. If you wish, you can receive a printout of each problem and its answer.

Minimum Required Equipment

- TRS-80 Pocket Computer, model PC-2 (26-3601)
- TRS-80 PC-2 Printer/Cassette Interface (26-3605)
- Cassette recorder

It is wise to make a backup (copy) of this package. Use your backup, and keep your original cassette in a safe place. See Appendix A — "Making a Backup."

Loading Instructions

1. Install the PC-2 in the printer/cassette interface, and connect the printer/cassette interface to the cassette recorder. Turn on the computer.
2. Turn the REM (Remote) switch off.
3. Insert the cassette in the cassette recorder and make sure the tape is fully rewound.
4. Adjust the volume on the recorder to the setting you have found to be the most effective. If there is a tone control, set it to maximum treble.
5. Turn the REM switch on. Set the computer's mode to RUN or PRO.
6. Press Play, type: **C L O A D** "program name", and press **ENTER**.
7. When the recorder stops, press Stop on the recorder.

Set the mode to RUN by pressing **MODE** until the word RUN appears at the top of the display. To start the program, press **DEF**, then **SPACE**. The display shows the program name and copyright, then the program begins.

Whenever the "P" to Print, ENTER prompt appears, press **P** **ENTER** if you want the computer to print the entire problem once it is solved. If you do not want a printout, press **ENTER** at this prompt.

WTWTVOL

WTWTVOL solves weight-weight and weight-volume problems. This program calculates the weight or volume of a particular compound resulting from a known reaction, when the weight or volume of reactants is known. If the compound is a gas, the result is given by volume in liters.

Operating Instructions

Load the WTWTVOL program. After the name and copyright notice appear, the display shows WT/WT or WT/VOL? (W/V).

Type **(W) (ENTER)** to solve a weight-weight problem or **(V) (ENTER)** to solve a weight-volume problem. After each problem, press **(ENTER)** to return to this display. You can begin another problem or press **(ENTER)** to exit the program.

To Solve Weight/Weight Problems

The display shows "P" to print, ENTER. Once you have entered your reply, the program asks for the weight in grams, the molecular weight, and the equation value of the first component in the equation. Once you enter the information, the program asks for the molecular weight and the equation value of the second component.

Note: The term "equation value" refers to the molecular quantity of a chemical reactant. For example, in the equation $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$, the equation value for hydrogen gas is 2.

When you have entered all the necessary information, the display shows the weight of the second component in grams.

Example

In this example the WTWTVOL program finds the weight of water produced by the decomposition of 100 grams of hydrogen peroxide. The chemical equation is:



The first component, hydrogen peroxide, has a molecular weight of 34 and weighs 100 grams. Water, the second component, has a molecular weight of 18.

The display shows:

```
WT/WT or WT/VOL? (W/V)
"P" to print, ENTER
Comp 1 wt?
Comp 1 mol wt?
Comp 1 eqtn value?
Comp 2 mol wt?
Comp 2 eqtn value?
Wt of comp 2 = 52.94117647
```

You type:

```
W (ENTER)
P (ENTER)
100 (ENTER)
34 (ENTER)
2 (ENTER)
18 (ENTER)
2 (ENTER)
(ENTER)
```

To Solve Weight/Volume Problems

In weight/volume problems one of the products of a chemical reaction will be a gas. Given the volume of the gas, the program finds the weight of the reactant. Given the weights of a reactant, the program finds the volume of the gas.

Press (V) at the first display to solve a weight/volume problem. Once you answer the "P" to print, ENTER question, the display shows (W)eight or (V)olume?.

Solving Weight Problems

Type **(W) (ENTER)** to find the weight of a reactant which produces gas. Enter the volume, in liters, of gaseous product to be generated.

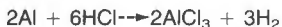
The program asks if the volume is at standard pressure and temperature. Type **(Y) (ENTER)** for Yes, or **(N) (ENTER)** for No. If the gas is not at standard pressure and temperature, you are prompted to enter the correct pressure and temperature. You may press **(ENTER)** at these prompts to assume the program's default values — 760 mm HG for pressure, 273.2 degrees Kelvin for temperature.

At the appropriate display, enter the equation value of the volume of gas. Next, give the computer the molecular weight or weight in grams and the equation value of the second component.

The program completes its calculations and displays the unknown weight. After receiving the printout or viewing the answer, press **(ENTER)** to return to the **WT/WT or WT/VOL? (W/V)** display.

Example

When hydrochloric acid attacks aluminum metal, aluminum chloride and hydrogen gas are produced according to this equation:



WTWTVOL calculates the amount of aluminum required to produce 35.7 liters of hydrogen gas. The temperature and pressure at the reaction site are 280 degrees Kelvin and 810mm Hg, respectively.

The display shows:

WT/WT or WT/VOL (W/V)

"P" to Print, ENTER

(W)eight or (V)olume?

Volume in liters?

Is volume @ STP? (Y/N)

You type:

V **(ENTER)**

P **(ENTER)**

W **(ENTER)**

35.7 **(ENTER)**

N **(ENTER)**

Pressure in mm Hg?	810 (ENTER)
Temperature Kelvin?	280 (ENTER)
Volume eqtn value?	3 (ENTER)
Comp 2 mol wt?	27 (ENTER)
Comp 2 eqtn value?	2 (ENTER)
Unknown wt = 29.83230381	(ENTER)

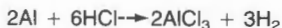
Solving Volume Problems

Type **(V) (ENTER)** at the (W)eight or (V)olume? display to find the volume of gas caused by a chemical reaction. Give the computer the weight in grams, molecular weight, and equation value of the reactant. Enter the equation value of the gas produced by the reactant. The computer finds the volume assuming standard temperature and pressure.

After receiving the printout or viewing the answer, press **(ENTER)** to return to the WT/WT or WT/VOL? (W/V) display.

Example

Using the same components as the last example, WTWTVOL calculates the amount of hydrogen gas produced by 10 grams of aluminum (molecular weight = 27). The equation is:



The display shows:

WT/WT or WT/VOL? (W/V)

"P" to Print, ENTER

(W)eight or (V)olume?

Comp 1 weight?

Comp 1 mol wt?

Comp 1 eqtn value?

Gas eqtn value?

Vol 12.44444444 liters

You type:

V (ENTER)

P (ENTER)

V (ENTER)

10 (ENTER)

27 (ENTER)

2 (ENTER)

3 (ENTER)

(ENTER)

The volume in the answer is always given assuming standard temperature and pressure.

EQUILIB

EQUILIB calculates either the pH or Ka constant of a weak acid solution from the acid's concentration.

Operating Instructions

Load the EQUILIB program. After the program name and copyright notice appear, you are asked if you want to print the results. The display then shows `Weak acid molarity?`. Enter the concentration of the acid. You can only exit the program at this prompt. To do so, press **ENTER**.

Calculating Ka

Enter **K** at the `Calculate (P)H or (K)a?` display. When you enter the pH for the solution, the computer finds the Ka value.

Example

EQUILIB calculates Ka for a .005-molar solution with a pH of 3.7.

The display shows:

"P" to print, **ENTER**

Weak acid molarity?

Calculate (P)H or (K)a?

PH of solution?

Ka = 8.29E-06

You type:

P **ENTER**

.005 **ENTER**

K **ENTER**

3.7 **ENTER**

ENTER

Calculating pH

Enter **(P)** at the Calculate (P)H or (K)a? display. Enter the value of Ka for the solution. The program gives you the hydronium ion concentration and then the pH for the solution.

Example

EQUILIB calculates pH for a .005-molar solution with a Ka of 8.29E-06.

The display shows:

Weak acid molarity?

Calculate (P)H or (K)a?

Value of Ka?

(H3O) + conc = 2.03E-04

pH = 3.69

You type:

.005 **(ENTER)**

P **(ENTER)**

8.29E-06 **(ENTER)**

(ENTER)

(ENTER)

IDEALGAS

IDEALGAS finds a single unknown in the ideal gas equation when you give the computer three of these four variables: pressure, volume, moles, and temperature.

Operating Instructions

Load the IDEALGAS program. After the program name and copyright notice appear, the display shows a general summary of the main responses you will use every time you run the program:

Enter null for unknown

This means you will press **(ENTER)** with no other input when the program prompts you to enter the variable you are calculating. For now, press **(ENTER)** to continue the summary.

Enter neg. Pressure to exit

This means you must enter a pressure less than zero to exit the program. Press **(ENTER)** to continue. At the next prompt, press **(ENTER)** to specify if you want to print the answer.

Enter the pressure, if known. The program asks how to measure the pressure. Enter **(A)** for atmospheres or **(M)** for mm Hg.

The program asks for volume, in liters, number of moles, and temperature for the gas. If you enter the temperature the display shows "C" if Celsius, ENTER. Type **(C)(ENTER)** for degrees Celsius. Press **(ENTER)** for Kelvin.

The program finds the unknown quantity. If you chose to print the problem, the display returns to the first prompt. If you did not request a printout, press **(ENTER)** to return to the summary display.

Example

12 moles of gas are stored in a 1 liter volume at 100 atmospheres pressure. IDEALGAS finds the temperature.

The display shows:

Enter null for unknown

Enter neg. pressure to exit

"P" to print, ENTER

Pressure?

(A)tm or (M)m Hg?

Gas volume? (l)

Number of moles?

Gas temperature?

101.6260163 degrees K

You type:

(ENTER)

(ENTER)

P (ENTER)

100 (ENTER)

A (ENTER)

1 (ENTER)

12 (ENTER)

(ENTER)

(ENTER)

MOLNORM

This program calculates molarity, normality and solute weights. Given the mass and molecular weight of solvent and solute, and the total ionized + charge of the solution, MOLNORM finds the molarity and normality. Given either molarity or normality and some information concerning the solvent, it calculates solute weight.

Operating Instructions

Load the MOLNORM program. After the program name and copyright notice appear, the display shows Find (C)onc or (W)t?. When you want to exit the program, press **ENTER** at this display.

Finding Concentration

Type **C****ENTER** to calculate the concentration. The program asks for the solute's molecular weight and weight in grams, and the solution's volume in liters. Once you enter the volume, the display shows the solution molarity. Enter the total ionized + charge for the solution. The display shows the solution normality. Press **ENTER**.

You are asked if you want to print the answer. Press **ENTER** at the "P" to print, ENTER prompt if you want to return to the first display.

Calculating Weight

Enter **W** at the Find (C)onc or (W)t? display. The display shows (M)olarity, (N)ormality?. Type **M****ENTER** to enter the solution molarity or **N****ENTER** to enter normality.

When you enter **M**, the program asks for the solution's molarity and volume in liters, and the solute's molecular weight. Once you enter the molecular weight of the solute, the display shows the solute weight in grams.

Press **ENTER** for the "P" to print, ENTER display. Type **P****ENTER** to print the problem. Press **ENTER** to return to the Find (C)onc or (W)t? display.

If you enter **(N)** at the **(M)olarity, (N)ormality?** display, the program asks for the solution's normality and ion factor. After you enter the solution ion factor, the display shows the solute weight. Press **(ENTER)** to continue to the **"P" to print, ENTER** display.

Example

In this example MOLNORM calculates the molarity and normality of a solution of 6.88 grams of sodium chloride, dissolved in enough water to make a volume of .560 liters.

The display shows:

Find **(C)onc or (W)it?**

Mol wt of solute?

Solute wt? **(gms)**

Solution volume? **(l)**

Molarity = **0.211**

Total ionized + charge?

Normality = **0.211**

"P" to print, ENTER

You type:

C (ENTER)

58 (ENTER)

6.88 (ENTER)

.56 (ENTER)

(ENTER)

1 (ENTER)

(ENTER)

P (ENTER)

BPFP

This program calculates the boiling point elevation and the freezing point depression of a given solution.

Operating Instructions

Load the BPFP program. After the program name and copyright appear, you are asked if you want to print the answer. The program then asks for the solute mass. Enter the mass of the solute in grams or press **(ENTER)** to exit the program.

The program asks for the solute's molecular weight, for the solvent's mass, and whether the solvent is water.

If the Solvent is Water

The program asks if the solute is an electrolyte. If the solute is not an electrolyte, type **(N) (ENTER)**. The program gives you the boiling point and freezing point of the solution. If the solute is an electrolyte, enter the ion factor of the solute. Once you enter the ion factor, the display shows your answer.

If the Solvent is Not Water

The program asks for the solvent's boiling point (BP) and freezing point (FP), on the Celsius scale. Next, the program asks for the elevation of the solvent's boiling point and the depression of the solvent's freezing point. The display shows the solution's boiling point and freezing point.

If you chose to print the problem, the display returns automatically to `Solute Mass? (gms)`. If you did not receive a printout, press **(ENTER)** to return to `Solute Mass? (gms)`.

Example

44 grams of calcium chloride are dissolved in 210 grams of water. The formula for calcium chloride is CaCl_2 . Since 3 ions are produced by the dissolution of one molecule, the solute's ion factor is 3. BPFP calculates the freezing and boiling points of the solution.

The display shows:

"P" to Print, ENTER

Solute mass? (gms)

Solute molecular wt?

Solvent mass? (gms)

Is solvent water? (Y/N)

Solute electrolyte? (Y/N)

Ion factor?

Solution BP = 102.9714286

Solution FP = -10.62857143

You type:

P (ENTER)

44 (ENTER)

110 (ENTER)

210 (ENTER)

Y (ENTER)

Y (ENTER)

3 (ENTER)

(ENTER)

(ENTER)

KSP

Given a solubility product (Ksp), KSP calculates the approximate solubility of a salt. Given the solubility of a salt, KSP calculates the approximate solubility product.

Operating Instructions

Load the KSP program. After the program name and copyright notice appear, the display shows (S)olubility or (K)sp?. Type (S) **ENTER** to solve for solubility or (K) **ENTER** to solve for Ksp. You can exit the program only at this prompt. To do so, press **ENTER**.

The display shows Assuming salt type <MX> then M ions per formula?. Enter the number of metal ions in the salt molecule. When the display shows X ions per formula?, enter the number of nonmetallic ions per molecule.

The program asks for either the Ksp value for the salt or the salt's solubility. Once you enter one variable, the program calculates the other.

At the end of each problem, you are asked if you want to print the answer. The display then returns to (S)olubility or (K)sp?.

Example

Silver carbonate (Ag_2CO_3) has a solubility of .00053 moles/liter under certain conditions. KSP calculates the Ksp for the salt.

The display shows:

(S)olubility or (K)sp?

Assuming salt type <MX>,
M ions per formula?

X ions per formula?

Solubility (M/l)

Ksp = 4.516E-15

"P" to Print, ENTER

You type:

K **ENTER**

2 **ENTER**

3 **ENTER**

.00053 **ENTER**

ENTER

P **ENTER** or **ENTER**

FORMWTS

This program calculates the formula weight of a molecular compound when you give it the elements that make up the compound.

Operating Instructions

Load the FORMWTS program. After the name and copyright appear, you are asked if you want to print the answer.

Once you enter an element symbol, the program looks for the element's atomic weight. If the element is not in the program's table, the program asks for the atomic weight.

Enter the number of atoms of the element in the molecular compound. The display returns to `Element symbol?`. Press **(ENTER)** at the `Element symbol?` display when all the elements in the compound have been entered.

The display shows the molecular weight of the compound. If you choose to print the problem, the program ends. If you did not receive a printout, press **(ENTER)** to end the program.

Example

The FORMWTS program calculates the molecular weight of water (H_2O).

The display shows:

"P" to print, ENTER

Element symbol?

How many H atoms?

Element symbol?

How many O atoms?

Element symbol?

Formula wt = 18.016

You type:

P **(ENTER)**

H **(ENTER)**

2 **(ENTER)**

O **(ENTER)**

1 **(ENTER)**

(ENTER)

PH

This program performs pH calculations. Given either H^+ ion concentration, OH^- ion concentration, or pH, PH calculates the other factors.

Operating Instructions

Load the PH program. After the program name and copyright appear, the display shows this menu:

Enter: H^+ OH^- PH end

Press (F3) to enter H^+ concentration and find the OH^- concentration and the solution pH, (F4) to enter the OH^- concentration and find the H^+ concentration and the solution pH, or (F5) to enter solution pH and find the H^+ concentration and the OH^- concentration. Press (F6) to exit the program.

After each calculation, you are asked if you want to print the answer. The program then returns to the menu.

Example

In this example, the program calculates the H^+ and OH^- concentrations for a weak base solution with a pH of 8.2.

The display shows:

PH value?

H^+ conc. = $6.30E-09$

OH^- conc. = $1.58E-06$

"P" to print, ENTER

You type:

8.2 (ENTER)

(ENTER)

(ENTER)

P (ENTER) or (ENTER)

METRIC

METRIC converts most common English units of measure to metric units.

Operating Instructions

Load the METRIC program. After the name and copyright notice appear, the display shows `List known units? (Y/N)`. Type **Y** **ENTER** for a list of abbreviations of the English units the program recognizes:

`IN FT YD MI OZ LB CP`

Press **ENTER** to continue the list.

`PT QT GAL BTU DEG`

Type **N** **ENTER** to skip the abbreviation display.

Note:

IN = inch

CP = cup

FT = foot

PT = pint

YD = yard

QT = quart

MI = mile

GAL = gallon

OZ = ounce

BTU = British Thermal Unit

LB = pound

DEG = degrees, in Fahrenheit

You are asked if you want to print the answer. At the next prompt, enter the number of units to be converted, a space, and an abbreviation for the English unit. You can exit the program only at this prompt. To do so, press **ENTER**.

The display shows the results of the conversion. After receiving the printout or viewing the answer, press **ENTER** to return the display to `Amount, space, unit?`.

Example

The display shows:

List known units? (Y/N)

IN FT YD MI OZ LB CP

PT QT GAL BTU DEG

"P" to print, ENTER

Amount, space, unit ?

12.7 cm

You type:

Y **ENTER**

ENTER

ENTER

P **ENTER**

5 IN **ENTER**

ENTER

ATOMWTS

This program is an electronic periodic table. When you enter an element symbol or number, ATOMWTS finds the number, name, and atomic weight of the element.

Operating Instructions

Load the ATOMWTS program. After the name and copyright appear, you are asked if you want to print the answer.

The display shows `Element?`. Enter an element symbol or an element number. Press `(ENTER)` with no other input to exit the program.

If the element is in the program's data table, the display shows its number, name, and atomic weight. If you chose to print the information, you receive a printout after each description.

Press `(ENTER)` to return to the `Element?` display.

Example

The display shows:

"P" to Print, ENTER

Element?

HE: 2 Helium 4.0026

Element?

MG: 12 Magnesium 24.305

Element?

HG: 80 Mercury 200.59

You type:

`(ENTER)`

HE `(ENTER)`

`(ENTER)`

MG `(ENTER)`

`(ENTER)`

HG `(ENTER)`

`(ENTER)`

Appendix A — Making a Backup

A Backup is a tape copy of a program and is an extremely effective method of insuring that an accident or equipment fault will not result in the loss of software. Your first action as owner of this software package should be to make working copies of the original cassette(s) and then put the original(s) away in a safe place.

Although it may be possible to make direct copies using two cassette recorders or on cassette duplicating equipment, the most reliable method is to use the computer itself to make the Backups. Also, for frequently used programs, you may wish to put them on separate cassettes for easier loading. Here are step-by-step instructions for making a Backup:

1. Install the computer in the Printer/Cassette Interface, and connect the Printer/Cassette Interface to the cassette recorder. Make sure the REM (Remote) switch is off.
2. Place the cassette containing the program(s) to be copied in the recorder and rewind the tape to a blank area just prior to the desired program. Make a note of the counter number marking the start of the program you're reading, and turn the REM (Remote) switch on. Place the recorder in the "Play" mode. Adjust the volume to the setting you have found most effective for making backups on your recorder. If your recorder has a tone control, set it at maximum treble. Most cassette recorders give better results with an external power supply than with batteries. If batteries are used, make sure they're really fresh.
3. Turn on the computer, make sure that it is in RUN or PRO mode, and type: **C L O A D** "name", and press **ENTER**. (Name refers to the name of the program to be copied.)
4. When the program has been loaded into the computer and the cassette has stopped, verify the load. Turn the REM (Remote) switch off, and rewind the recorder to the blank space just prior to the program. Turn the REM switch on, and put the recorder into the Play mode. Type: **C L O A D** "name" and press **ENTER**.

Note: The name of the file is optional. If you do not specify it, the computer loads the first file encountered.

The computer compares the cassette program with the program in its memory. If the load is good, the recorder stops at the end of the program and the prompt sign (>) reappears on the display. The display indicates if an error occurred during the load verification.

If an error message appears, press the (CL) (clear) key and check for the following problems:

- Low Batteries
- Bad tape
- Dirty or magnetized tape head in cassette recorder
- Incorrect volume setting

Then try the CLOAD function again, and verify the load.

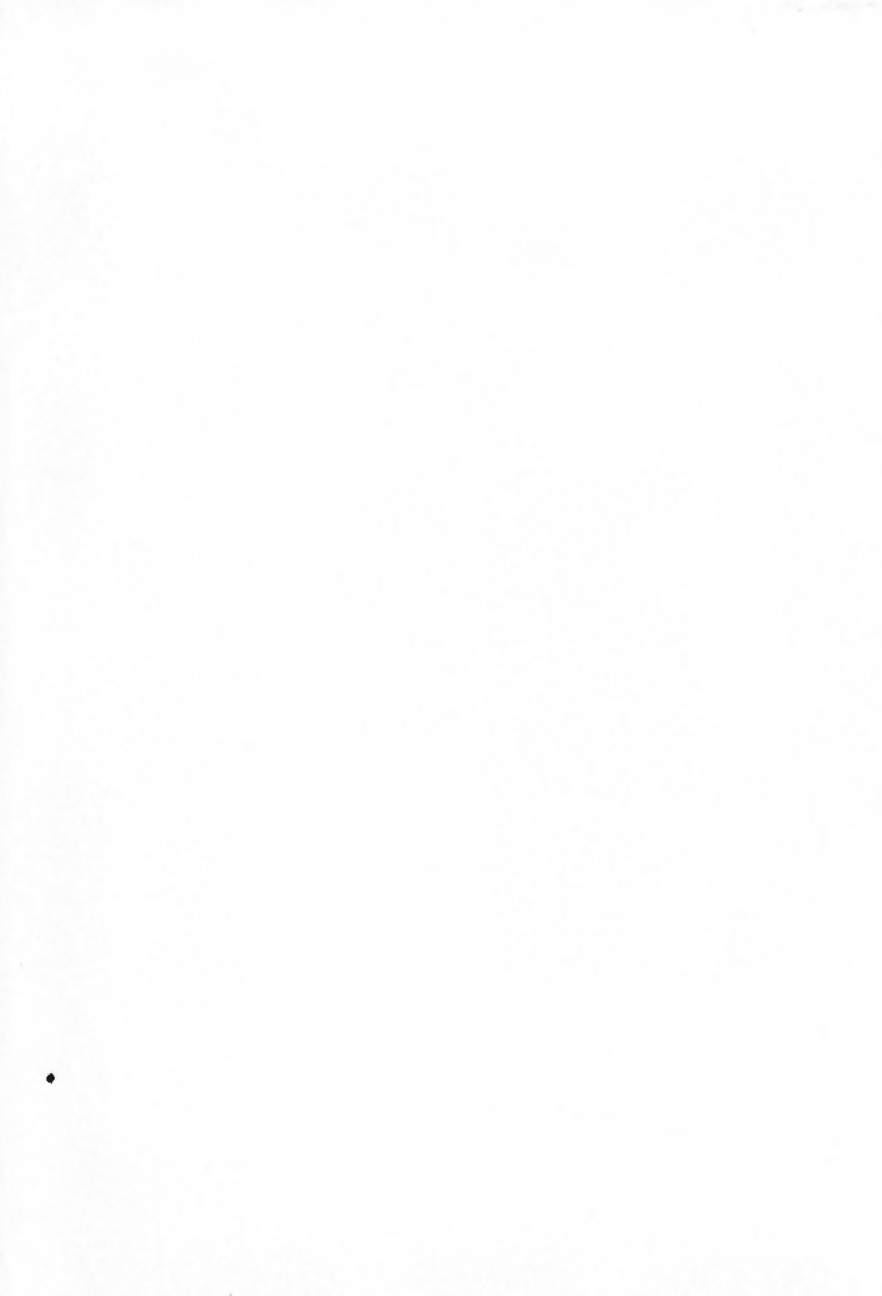
NOTE: If you wish to check the meaning of an error code, refer to the appropriate owner's manual.

5. When the program has been loaded successfully, remove the cassette and replace it with the cassette that is to receive the program copy. Turn the REM switch off, and rewind the tape to the point where the copy is to start. Make a note of the counter number where your saved information begins. You should leave from 5-10 seconds of blank space if the copy is to follow another program on the same cassette. Turn the REM switch on, and place the recorder in "Record" mode.
6. Type: (C)(S)(A)(V)(E)("name") and press (ENTER). The recorder will save your program.
7. To make absolutely sure that the program has been saved correctly, use the verification procedure as described in the fourth instruction of this appendix. Then, use the CSAVE function once more to make a second backup, and verify the save. It is recommended that you use TRS-80 certified cassettes (or Radio Shack Supertape) for backing up your Pocket Computer-2 programs.
8. Back up each program using steps 1 through 7 above.
9. Put the original cassette(s) away in a safe place and use them only for making working copies.

Appendix B — Maintenance

Maintenance of your Pocket Computer-2 system is not difficult. Attention to the simplest points listed below should provide the best reliability and satisfaction:

1. Keep your program cassettes in their boxes when not in use. Do not expose cassettes to temperature extremes or magnetic fields. Never touch the exposed surface of the tape on the front edge of the cassette.
2. Clean and demagnetize the tape heads in the recorder at regular intervals. Follow the recommendations in the cassette recorder's manual.
3. The most reliable loading and saving is achieved by operating the cassette recorder on AC current, rather than batteries.
4. Use only fresh alkaline-type batteries in the recorder when operating your system away from AC current.
5. Always press the recorder's "Stop" key immediately after loading or saving a program. This will release the pressure on the rubber roller which pulls the tape and prevent the roller from damaging the tape at the point of contact.
6. Always turn the computer off before installing it in or removing it from the Printer/Cassette Interface.
7. After removing the computer from the Printer/Cassette Interface, be sure to reinstall the protective plug to keep dirt out of the connector on the computer. Never touch the exposed parts on the Printer/Cassette Interface.



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**U.S.A.: FORT WORTH, TEXAS 76102
CANADA: BARRIE, ONTARIO L4M 4W5**

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